OVERUNITY ELECTRICITY

Hall Effect Device

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Device that collects energy from Ether - Radiant energy

Nikola Tesla was the first to develop a device that could collect energy from ether – radiant energy. He called it Wardenclyffe Tower. After Tesla's death, Dr. T. H. Moray continued development of this technology and eventually came up with a version that operated in resonance form. Moray's device was able to produce 50,000 watts of power output and it operated for over 25 years without any maintenance or repairs.

Nikola Tesla's work on developing free energy from ether technology was continued by Moray, who developed a device that collected energy from the ether in resonance form. This device offered a different version of free energy that was not dependent on batteries.

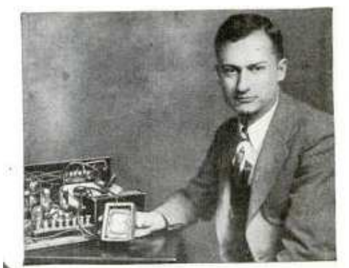
Moray's device is a generator that uses a grounded electronic circuit, to pull infinite energy, from the surface of the earth. The device works by pulling energy from the ether-a cosmic sea of energy that pervades all of space. This infinite source of energy can be used to power our homes and vehicles, and to eliminate our dependence on fossil fuels.

The article guides to practice a version of using electronic circuits to resonate, creating free energy: Radiant Energy with Bifilar coil - Impulse Technology

"Tubeless Receiver Claimed by Professor, Using Bismuth & Copper" by Robert Bangs

Radio World (January 29, 1927), p. 11

Recently it was announced at Mercer University (Macon GA), that the Westinghouse Electric & manufacturing Co. had offered Dr. Palmer H. Craig, head of the physics department of the university, $100,000 for a new device which is supposed to replace vacuum tubes as amplifiers and detectors.



Batteries and vacuum tubes in radio sets may become a thing of the past, with this amazing invention of Dr. Palmer H. Craig, of Cincinnati. Bismuth plates, it is said, generate the energy to operate the radio set, and serve as detector and amplifier

The device is called an "electromagnetic detector and amplifier" and consists of a series of bismuth plates stacked in a pile and interlaced with copper wires. The bismuth plates are protected by a coating of sulfur because bismuth, a very brittle substance, is likely to crumble.

Long Sought After

Many attempts have been made by various investigators to make use in this manner of the this property of bismuth and of similar properties of allied metals but so far there has been no claim of success, until Dr. Craig came along. The most common attempted application is to the

rectification of AC for filament and plate voltage supply. Lack of efficiency and of dependability have been the main causes of failure. Another limitation is the supply of suitable metals in commercial quantity.

One of the metals which displays similar properties is molybdenum. This has been used by scientists of the Bureau of Standards for converting light energy from the sun into electricity.

From Earth To Sun!

A certain amount of success has been achieved and it seems possible that power may soon be derived directly from the sun in this manner. Here, also, lack of efficiency and of adequate supply of the metal are limitations. There is plenty of molybdenum to be had in different parts of the world, but not all molybdenum is suitable for the purpose. There seems to be an active component in the metal which is responsible for the peculiar property, and it is now the aim of the scientists to isolate this substance.

Apropos the offer to Dr. Craig, Dr. Alfred N. Goldsmith, of the Radio Corporation of America, denied that any such offer has been made for Dr. Craig's device. Dr. Goldsmith, chief broadcast engineer of the corporation, deprecates the idea that the peculiar property of bismuth can be used for the purpose claimed by Dr. Craig.

He is Not Yet Thirty

Dr. Craig emphasizes the point that the device will displace batteries as well as vacuum tubes in radio sets.

Dr. Craig, who is not yet 30, developed the invention, upon which he immediately applied for a patent, for his thesis at the University of Cincinnati where he received his degree of Doctor of Philosophy last June.

When asked to show the invention, Dr. Craig drew out a small block of substance resembling sulfur. It was an inch thick, about 3 inches long and 2 inches wide. Protruding from the top were tiny wires. It was encased except for the top.

He styled the device "an application of bismuth plates as detectors and amplifiers", which could be used in place of present batteries and vacuum tubes in a radio.

What He Found Out

In his research for his Ph. D. degree at the University of Cincinnati, Dr. Craig found that the bismuth plates might be so used and the actual invention is described in part in his doctor's thesis.

The inventor today spoke of the device as "a series of about 10 thin bismuth plates, piled one on the other, with wires running between them and finally on out to the actual radio set."

Because of the delicate nature of the bismuth plates, Dr. Craig has protected them with a covering of sulfur. According to the inventor, the bismuth plates will generate the energy necessary to operate the radio and serve as a detector and amplifier.

Describes Process

The process is described in the scientist's thesis as follows:

"The author is at present using this additive principle in an application of the Hall effect to rectification of alternating current, with a method similar to that described by Descoudres.

"The additive principle used in this connection produces a Hall potential of several volts in low fields with thin bismuth films, and thus gives the Hall effect a practical importance as a rectifier, especially in radio and similar applications."

***Physical Review* 27: 772-778 (June 1926)**

The Hall Effect in Bismuth with Low Magnetic Fields

by
Palmer C. Craig

Abstract --- The Hall effect in bismuth for a magnetic field strength of from 0.07 to 1.00 gauss was accurately determined by improved methods. Production of the bismuth films. Various methods for obtaining excessively thin, homogenous bismuth films were tried and compared, such as casting, electroplating, evaporating, sputtering, and metallic spraying, of which the last three methods were particularly successful. Measurement of very low voltages. By refinements made in the potentiometer and measuring circuits, reading to one-tenth microvolt were accurate and reproducible. Magnitude of the Hall effect at low fields. The value of the Hall coefficient, R, is abnormally large between 0.07 and 0.30 gauss, having a value of -171 at 0.07 gauss, as compared with a value of -11 which R had for this film at 15 gausses. The value at 4220 gausses was -29, A curve is plotted showing the rapid decrease in the value of -R between 0.07 and 0.30 gauss, and comparison is made with higher values of field strength. It is noted that by putting the Hall potential of one film in series with one or more other films we obtain comparatively high values of the Hall emf, which may be applied to great advantage as an alternating current rectifier in radio and similar applications.

Introduction

Since the discovery of the Hall effect in 1875 much has been done to elucidate this phenomenon both experimentally and theoretically. But, with the exception of Righi (Ref. 1), who employed fields comparable to that of the earth, and a few others, almost all investigators have used strong

fields. It is important to know accurately the effect of low fields, to compare it with the known facts and to determine whether any abnormal relations exist. As the effect of the magnetic field is small in all cases, a great refinement of the potentiometer and measuring circuits is imperative with weak fields, and the preparation of the bismuth strips presents great difficulties and requires special methods.

Preparation -- Experimental Arrangements

Since the Hall effect increases with the thinness of the metallic strips, the first requisite was to prepare extremely thin films of metal. Bismuth and tellurium, which have the highest Hall coefficient of the ordinary metals, were selected and six different methods were tried in order to find the best and quickest way of making films which would be extremely thin and at the same time electrically continuous. These processes were casting, dipping, spraying, electroplating, and sputtering.

Thin films of bismuth cannot be produced by casting unless pressure is exerted on the surface of the metal as it cools, and provision must then be made for lateral expansion when solidifying.

Surprisingly thin and uniform films were, however, obtained by dipping mica sheets into molten bismuth and using the metallic film which adhered to the mica. If the surface of the mica be slightly roughened with hydrofluoric acid, and care be used in withdrawing the mica from the molten metal, a very thin and uniform film can be obtained by this very simple and rapid method.

Much work was done by the author to produce very thin plates of bismuth and tellurium by the process of spraying molten metal. Excellent results were obtained both with the "Schoop" compressed air metallic spraying process, and also with the "Gravitas" metal dust spraying process. Cooperation in this part of the work was kindly rendered by the Metals Coating Company of Philadelphia. Both of these spraying processes involve spraying metals in the molten state by means of a compressed air gun. In the case of bismuth it was found advisable to use compressed nitrogen, instead of air, in order to prevent oxidation of the sprayed layer. When applied to mica, glass, and bakelite, excellent films of both bismuth and tellurium were obtained.

Attempts to produce homogenous films by electroplating met with poor results, even when great care was used regarding temperature, speed of the rotating cathode, and concentration of solution.

Evaporation of molten bismuth in a partial vacuum produced very good results. Bismuth was placed inside an evacuated bell-jar and was melted by an electric heater. A glass plate, suspended above the arrangement, collected the evaporated bismuth in the form of excellent films.

Cathodic sputtering undoubtedly produces the thinnest films of any method. With reasonable care bismuth films can easily be prepared by this method so thin as to be quite transparent. Sputtering was accomplished by applying the secondary current of a 20,000 volt transformer to anode and cathode electrodes placed inside a bell-jar evacuated to 30 microns. Rectification of the secondary current by a kenetron accelerated the action. A disc of bismuth 3.5 inches in diameter was used as a cathode, and the glass plate on which the film was to be sputtered was placed just outside the Crookes' dark space, which was about 2 cm long. With a current of 5 milliamperes excellent films were produced on glass in about 20 minutes.

Disposition of the Apparatus

The very weak magnetic films employed in this work were obtained from an air core solenoid. When a given current is passed through such a coil the field at the center is easily calculated. This calculated value was checked by a calibrated ballistic galvanometer in conjunction with a flip coil. The actual coil employed consisted of 100 turns of wire wound on a rectangular wooden form 8 x 11 cm in cross-sectional area, the size of this form being just large enough to accommodate the film used. The inductance of this coil was 2.5 millihenries, and it was therefore necessary to pass 35.2 milliamperes through it in order to get a field of one gauss at the center. Because of the extremely low values of the magnetic field used, it was necessary to shield the arrangement carefully from any action of the earth's and stray fields. Several methods were tried to accomplish this shielding, the one finally adopted being that of placing the set-up so that the plane of the bismuth field coincided exactly with the magnetic inclination of the earth's field at that point, thus eliminating any magnetic component in a direction perpendicular to the plane of the magnetic film. Care was taken to keep all iron away from the vicinity of the apparatus, and upon actual measurement stray fields were found to be negligible.

Chemically pure bismuth for producing the films was furnished by Eimer and Amend and the film itself, obtained by any one of the previously described methods, was mounted on bakelite with sodium silicate as a binder. Contact at the ends for the longitudinal current was made by phosphor-bronze spring clips, and contact at the edges of the film, for picking up the transverse Hall potential, was obtained by means of small brass fingers attached to machine screws passed through the bakelite. The surface of the film was carefully cleaned with weak hydrochloric acid solution to remove surface oxides, and the entire film and connections were then painted with sodium silicate to keep semi-conducting layers of dirt and moisture from collecting on the surface of the film. In some cases it was even found advisable to mould the entire arrangement in sulfur to obviate this difficulty.

Since the potential differences to be measured were of the order of one microvolt, extreme care was taken to render the measuring apparatus very accurate and stable. The transverse Hall effect potential was measured by means of a Leeds and Northrup type K potentiometer, redesigned with a system of calibrated external shunts which increased the sensitivity of the instrument 10 times. Four galvanometers of varying degrees of sensitivity were used with potentiometer for null readings, the most sensitive galvanometer having a sensitivity of 12.2 mm per MV. The longitudinal current through the film was supplied by large storage cells, the output of which passed through a large filter system of two very large inductances in series with the line, the lines being shunted by two condensers of 6 microfarads each. This filter eliminated erratic action caused by sudden fluctuations of the longitudinal current occasioned by bubbling of the cells.

The main current through the potentiometer itself was passed through a similar filter and was allowed to flow overnight before taking readings so that greater stability could be expected. The null potentiometer reading on the standard cell was checked before and after and after each measurement.

Greater care was taken to eliminate all spurious effects. Thermal effects, of course, construed the greater part of these corrections. Junctions of dissimilar metals in the circuit were reduced to a minimum, and the remaining potentials due to Thomson and allied effects were accurately measured the instant the longitudinal current was broken. Grounding one side of the potentiometer circuit was found to increase stability.

For the work at high magnetic fields, a large electromagnet was used. This magnet was capable of producing a field of 18,000 gausses in a narrow air gap, the field of which was measured by a calibrated ballistic galvanometer in conjunction with a flip coil.

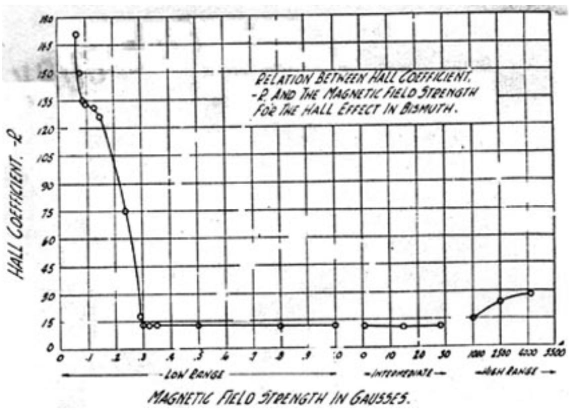
Experimental Results & Discussion

Using a bismuth film obtained by metallic spraying, 3.5 x 8.0 cm in area and 0.012 cm thick, the results shown in Table I were obtained. These results are in agreement with those obtained with films of the other type described previously. In this table three different ranges of magnetic field strength were investigated with the same bismuth film and under the same general conditions. A longitudinal current of 1.5 amperes was used throughout Table I. The "residual" emf (measured in microvolt) which is referred to in the second column is the potential difference caused by the fact that the brass fingers which pick up the transverse Hall potential cannot possibly be placed at exact equipotential spots with regard to the longitudinal current. These contacts were placed as near to equipotential points as possible and the remaining difference of potential was measured as given in the second column of the table. The second and third columns automatically include the sum of the thermal effects, since it is of course impossible to eliminate the thermal potentials from the potentials indicated in these columns. However, the spurious effects are eliminated when column two is subtracted from column three in order to get the net Hall emf in the fourth column. The Hall coefficient, R, given in the fifth column is calculated from the usual formula (Ref. 2),

$R = Ed / IH$,

Where R is the Hall coefficient, d the thickness of the film in centimeters, i the longitudinal current in abamperes, H the magnetic field strength in gausses, and E the net Hall emf.

Figure 1: Relation between Hall coefficient, -R and the magnetic field strength for the Hall effect in bismuth



It is immediately apparent that the Hall coefficient is abnormally high in the range of very low fields, and falls rapidly in value as the field is slightly increased. Reference to the graph (Figure 1) shows a slight irregularity near 0.1 gauss, a straightening out of the curve at about 0.3 gauss, and then an approximately linear relation until a field strength of 1.0 gauss is reached. Reading s in an intermediate range of zero to 30 gauss showed that -R is practically constant at a value of 10.27 which Von Ettingshausen and Nernst found for bismuth at a field of 1650 gausses. In the range from 1000 to 4200 gausses the coefficient increases slightly from 15 to 29. This curve was selected from a dozen similar graphs as being one of the most representative, and the irregularity in the neighborhood of 0.1 gauss is typical of similar irregularities in all curves obtained with the various films.

These results show that the value of -R at very low fields is higher than has been heretofore suspected and that the curve for -R, plotted against field strength, shows a marked rise in this low range.

Each of the values in Table I are average values for approximately 12 readings at each value of field strength. These readings are reproducible to approximately one-tenth of a microvolt, and the readings forming the averages did not vary more than this amount.

Table I: Hall effect in bismuth for low, intermediate and high fields

Gausses	Residual emf	Residual + Hall emf	Net Hall emf	-R
0.07	14.0 microV	15.5 microV	1.5 microV	171
0.08	14.1	15.6	1.5	150
0.09	14.2	15.7	1.5	135
0.10	14.2	15.8	1.6	133
0.13	14.4	16.1	1.7	131
0.15	14.3	16.9	2.6	126
0.24	14.0	16.3	2.3	75
0.29	14.6	21.1	6.5	18
0.30	14.5	19.8	5.3	14
0.32	14.4	19.6	5.2	13

0.35	14.8	20.5	5.7	13
0.50	14.6	22.7	8.1	13
0.80	14.6	26.6	12.0	12
1.00	14.6	29.6	15.0	12
1.0	14.5	29.5	15.0	12
15.0	14.3	35.1	20.8	11
28.5	14.4	60.4	46.0	11
1000	14.0	1889.0	1875.0	15
2500	14.0	7514.0	7500.0	24
4220	14.0	15324.0	15310.0	29

During the course of the experiments an interesting incidental fact was discovered, namely that the Hall effect of one film may be put in series with that of one or more other films, the sum of these series potentials agreeing very well with the calculated sum of the Hall potentials of the individual films as observed separately. Although this fact has little application where quantitative readings of a high degree of accuracy are desired, it is of real importance in any application where larger values of Hall potential are desirable than those which can be obtained with a single film. The author is at present using this additive principle in an application of the Hall effect to rectification of alternating current with a method similar to that described by Descoudres (Ref. 4). The additive principle used in this connection produces a Hall potential of several volts in low fields with thin bismuth films, and thus gives the Hall effect a practical importance as a rectifier, especially in radio and similar applications. Work on the additive principle is also being done by Sarek (Ref 5).

The results here presented indicate that there is considerable work to be done in further investigating abnormalities in the Hall coefficient at very low fields, and also suggest that certain modifications or explanations will have to be introduced into the theory of the Hall effect to account for the interesting changes in the Hall coefficient at low fields.

In conclusion, the author wishes to acknowledge his indebtedness to Dr. Louis T. More, Dr. R.C., Gowdy, and Sr. S.J.M. Allen for their kind help and valuable advice tendered throughout the progress of the work.

Ref. 1 ~ Righi: Journale d. Physique 3: 127 (1884)
Ref. 2 ~ L.L. Campbell: "Galvanomagnetic & Thermomagnetic Effects", p. 9
Ref. 3 ~ Von Ettinghausen & Nernst: Wied. Ann. 29: 343 (1886)
Ref. 4 ~ Des Coudres: Phys. Zeitschrift 2: 586 (1901)
Ref. 5 ~ Sarek: Eleck. U. Maschinenbau 43: 172 (1925)

U.S. Patent 1,822,129
(Sept. 8, 1931)

System & Apparatus Employing the Hall Effect

Palmer H. Craig

My invention relates broadly to electrical apparatus for modifying the behavior of electrical current and more particularly an apparatus for effectively employing the transverse potential difference in certain metallic plates when subjected to the action of a longitudinal current and the influence of a magnetic field.

One of the objects of my invention is to provide a device consisting of a plurality of rectangular metallic foil sheets or metallic alloy plates in stacked arrangement insulated one from another and electrically connected in parallel at opposite ends thereof and in series along the transverse axis thereof, whereby current of direct current characteristic may be secured in a circuit which connects to points along the transverse axes of the plates when alternating current is supplied to the opposite end of the plates and a magnetic field created around the plates.

Another object of my invention is to provide a construction of fixed rectifier for alternating current which remains in permanent adjustment and does not require resetting from time to time.

Another object of my invention is to provide a device for modifying electrical current of alternating characteristic for rectifying, amplifying, or causing the generation of electrical oscillations of any selected frequency.

Still another object of my invention is to provide an electrical apparatus particularly adapted for operation in conjunction with the circuits of a radio receiving system for rendering feeble signal currents observable.
A still further object of my invention is to provide an apparatus unit which may be connected in circuit with electron tube apparatus for facilitating the operation of the electron tube apparatus in the reception of signaling energy.

Other and further objects of my invention will be understood from the specification hereinafter following by reference to the accompanying drawings in which:

Figure 1 represents in perspective view the arrangement of parts in the apparatus of my invention; Figure 2 is an end view of the apparatus showing more clearly the direction of the magnetic field perpendicular to the plane of the metallic plates; Figure 3 is a schematic view showing the arrangement of the metallic films which comprise the apparatus of my invention; Figure 4 is a diagrammatic view showing the wiring arrangement of the apparatus of my invention when used as a rectifier; Figure 5 shows one of the applications of my invention in a reflex signaling receiving circuit; Figure 6 illustrates an application of my invention as a detector in a radio circuit; Figure 7 shows a circuit arrangement which makes use of the principles of my invention in the amplification of signal energy, provision being made for facilitating the production of oscillations; Figure 8

shows a circuit arrangement wherein the longitudinal current which passes through the plates of the apparatus of my invention is derived from a source independent of the source which creates the magnetic field about the plates; Figure 9 illustrates a circuit arrangement employing a plurality of the devices of my invention as an amplifier of incoming signaling energy and as a rectifier of the amplified energy; and Figure 10 shows the fundamental arrangement of the magnetic field transverse to the plane of several metallic plates in the apparatus for developing the principles set forth herein.

Figure 1:

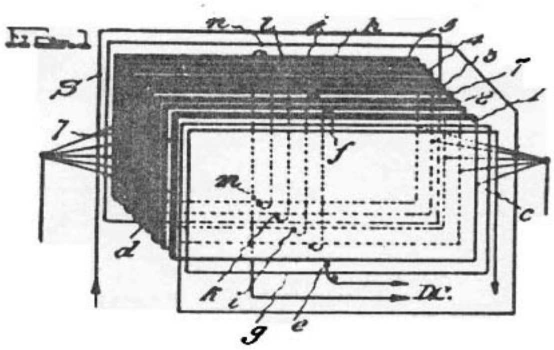


Figure 2:

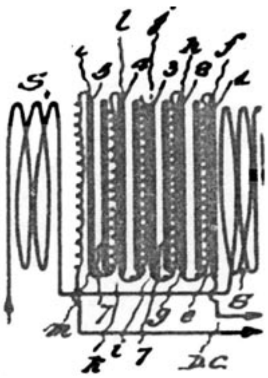


Figure 3:

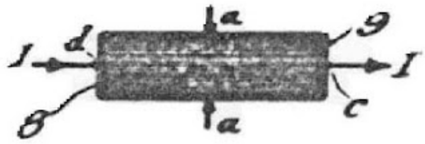


Figure 4:

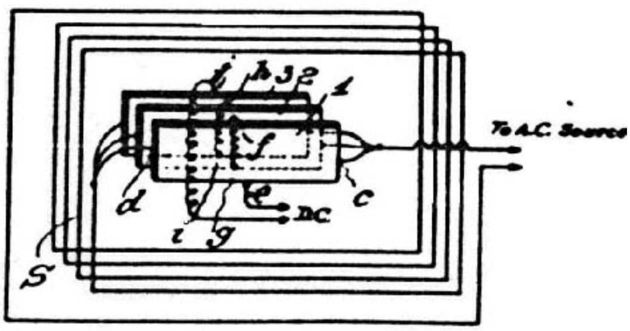


Figure 5:

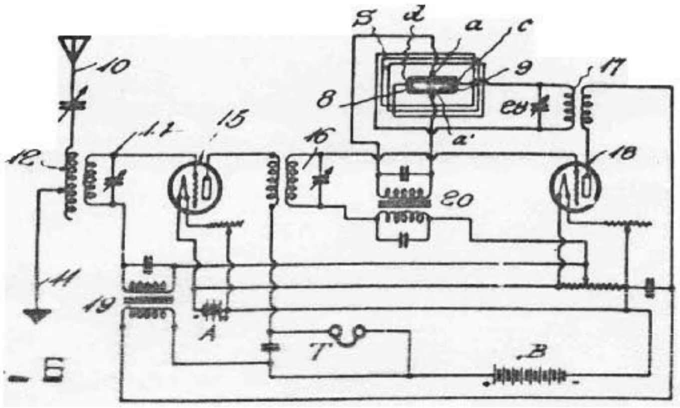


Figure 6:

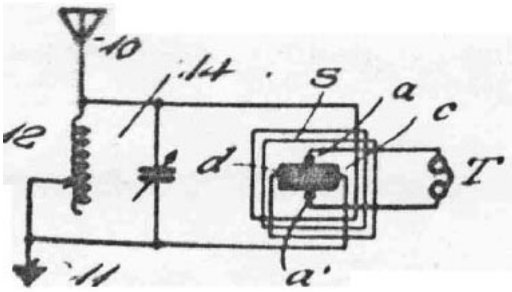


Figure 7:

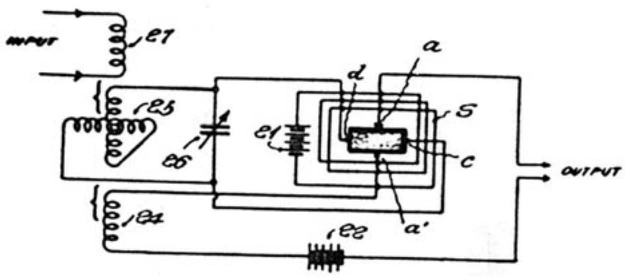


Figure 8:

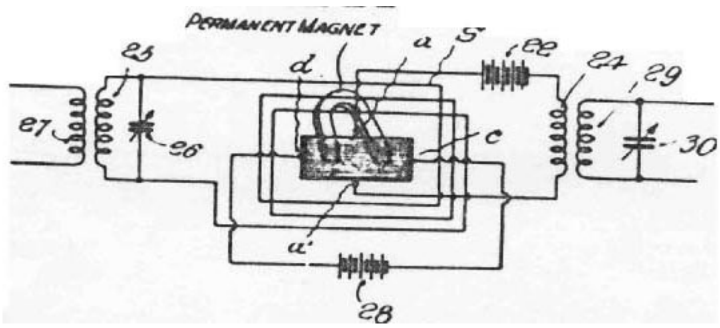


Figure 9:

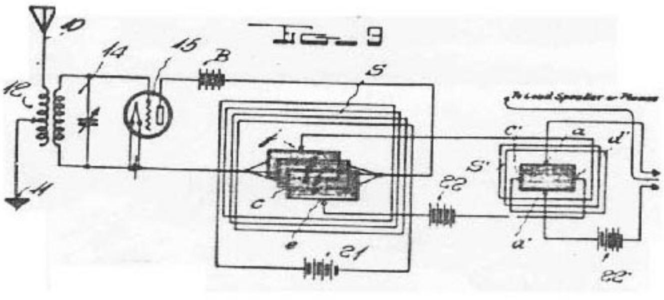
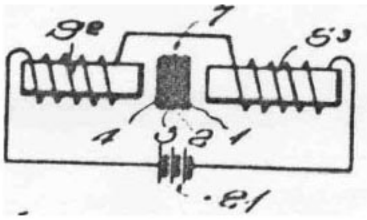


Figure 10:



My invention makes use of the "Hall", "Corbino" and similar electromagnetic phenomena for the rectification or amplification of alternating currents, and the generation of sustained electrical oscillations in electrical circuits.

The "Hall" effect consists, briefly, of an electromagnetic phenomenon observable when a strip or film of metal carrying a longitudinal current I, (Figure 3) is placed in a magnetic field perpendicular to the plane of such a strip, a transverse potential difference being set up between the edges a, a’, of the strip, this difference of potential being approximately, under normal condition represented by the formula:

$E = HI/d$

Where E = the transverse potential difference;
I = the current (longitudinal) through the strip;
d = the thickness of the strip;
H = the magnetic field strength

The "Corbino" effect is similar to the "Hall" effect, wherein a radial current through a circular disc subjected to a magnetic field perpendicular to the plane of the disc, produces a "circular" current through the disc.

I have discovered that if plates or films of metal such as bismuth, tellurium, bismuth-antimony alloy, or other metal or alloy, be connected as shown in the drawings, the devices will act as a practical electrical rectifier of impressed alternating currents. Refering to the drawings in Figure 4, the alternating current is sent through the strip 1 from c to d, in one-half of the cycle, and from d it enters the solenoid S, being an air-core or a core of magnetic material, thence after passing through the solenoid it returns to the alternating current source. In the other half of the cycle the operation is, of course, reversed.

Figure 4 also shows the method of stacking many plates 1,2 and 3 on top of one another, with suitable insulation between, and then connecting the positive "Hall" effect potential point of one plate to the negative "Hall" effect potential point of the one below, as represented in the drawings at e, f, g, h, i, and j. In other words, the transverse potential of all the plates 1,2 and 3 are put in series in order to add up to larger values of potential than would be obtained with a single plate.

It is obvious, that since the polarity of the "Hall" effect potential difference changes in synchronism with either the change in polarity of the points c and d, or with the change in direction of the magnetic flux through the plate, the polarity of the point e, j (Figure 4) will always be the same with respect to each other when both the magnetic flux and also the longitudinal current through the plates change in phase synchronously with each other, The arrangement shown in Figure 4 will then obviously give a pulsating direct current at the point e, j.

The construction of the apparatus of my invention is more clearly illustrated in Figure 1 where the metallic films have been represented at 1, 2, 3, 4 and 5 separated by insulated sheets 7. Opposite ends of the films are tapped as represented at c and d. The transverse axes of the films are connected in series as represented at e, f ,g, h, i, j, k, l, m, and n for delivering a direct current. The end view of the apparatus in Figure 2 shows more clearly the arrangement of the films and the dielectric sheets. The solenoid winding has been divided into two sections for producing a transverse magnetic field through the metallic films.

In Figure 3 I have shown a stacked arrangement of metallic films separated by insulated sheets in accordance with my invention, where the alternating current I passes along the longitudinal axes of the films from d to c. I provide copper end contacts 8 and 9 which bridge all of the metallic films enabling the films to be connected in the electrical circuit in parallel. The point contacts across the transverse axes of the films have been represented at a and a’.

The device may be used as a rectifier in ordinary electrical circuits where the power drawn from the rectifier is of sufficiently low value as to render the method practicable. The arrangement can also be used as a rectifier in radio transmitters and receivers, especially to replace the crystal detector or the triode vacuum tube detector in radio reception. It could be used either alone or in combination with electron tubes, a typical circuit diagram of the latter method being given in Figure 5.

Referring to Figure 5 in more detail the receiving antenna system is represented at 10 which connects to a ground system at 11 with a coupling inductance 12 therein coupled to the tuned input circuit 14 of the electron tube 15 which functions as a radio frequency amplifier. The output of the radio frequency amplification circuit 16 with the input circuit of a second stage of radio frequency amplification constituted by electron tube 18, the output circuit of which includes transformer system 17tuned as represented at 28 for supplying exciting current to solenoid S through a series circuit which passes through the longitudinal axes of the metallic films from points d to c. A direct current is derived across the points of contact a and a’ which is directly proportional to the incoming signaling energy. The rectified current is delivered through a transformer system 20 to the input circuit of the electron tube 18 which also functions as an audio frequency amplification system delivering its audio frequency output through transformer 19 with the input circuit of electron tube 15 which serves also to amplify at audio frequency delivering its output to telephones T. Battery A supplies filament heating current for the several tubes while battery B supplies space current for the tubes. The tuned system 17-28 permits a relatively large value of current to pass through the metallic films and thereby secure maximum direct current energy across the transverse axes of the metallic films. My invention may be applied to all standard circuits as well as to the reflex system of Figure 5.

Referring to Figure 6 a simplified circuit as illustrated showing the application of the principle of my invention to a simple radio receiving apparatus. In this circuit the incoming signaling energy delivered from tuned circuit 14 passes through the longitudinal axes of the metallic films from d to c at the same time setting up a magnetic field by means of solenoid S for deriving direct current across the transverse axes of the metallic films at a and a' proportionate to the incoming signal energy. This direct current directly actuates the telephone responsive device T.

It should be noted that, due to the fact that this system is a perfect rectifier (that is, it admits of no inverse potential or currents in the output) it will produce no distortion in the reproduction of radio telephone signals and voice, and is, therefore, far superior to either the crystal detector or the electron tube from the standpoint of faithful reproduction, in addition to its superior qualities of stability, ease of operation and lower cost of maintenance.

Figure 7 illustrates a circuit arrangement which I employ in the amplification of signaling energy by means of the apparatus of my invention. An input circuit has been illustrated in the form of an inductive coupler 25 tuned by variable condensor 26 and connected through the longitudinal axes of the metallic films at d and c. A permanent magnetic field may be established about the metallic films by means of a local source 21 connected in circuit with the winding S. An iron core may be provided for this solenoid S. Incoming signaling energy is supplied through winding 27 coupled with the windings 25. The transverse axes of the films at a and a' are connected in series with a local source 22, and an inductance 24 which couples with the inductance system 25. A desired degree of regenerative amplification is thus introduced for increasing the amplitude of the impulses of signaling energy delivered to the output circuit. The principle of my invention may be applied to an oscillator where the input coil 27 connects to a small local exciter of alternating current and the output connected through a transformer system. By employing selected values of inductance, capacity and resistance the system may be arranged to oscillate at either audio or radio frequencies.

Figure 8 illustrates a method of obtaining greater energy amplification in the apparatus of my invention. A permanent magnetic flux is set up through the thickness of the plates and also a permanent longitudinal current is established along the horizontal axes of the plates from a battery 28. A tuned input circuit system 27-25-26 is arranged to excite the winding s which encloses the stack of alternately positioned films and dielectric sheets. The longitudinal axes of the films are connected at points a and a' with an output circuit including a source of potential 22, and inductance 24. The inductance 24 is inductively coupled to an inductance 29 tuned by means of condensor 30 in the output circuit of the electrical system. The fluctuating magnetic field from the winding S which varies in proportion to the amplitude of the signaling energy is superimposed on the permanent field which is established.

The input may also be superimposed on the longitudinal current instead of upon the magnetic field. The local battery for supplying longitudinal current to the conductive field may thus be eliminated. The local battery 22 in the circuit of the electrical system is provided to boost the voltage of the output to a proper value for the operation of the succeeding amplifier stages or the reproducing unit, the "Hall" fluctuating potential being then superimposed upon this steady potential. By increasing the number of conductive films in parallel the effective potential may also be increased.

In Figure 9 I have shown an application of my invention to an electron tube circuit where the conductive films have their longitudinal axes connected in series in the output circuit of electron tube 15. A constant magnetic field is supplied from battery 21 to the winding S. In this manner the device operates as a radio frequency amplifier, delivering amplified energy to an output circuit across the transverse axes of the conductive films in series as represented at e and j, the output circuit including battery 22 and solenoid winding S'. The solenoid winding S' connects in series with the longitudinal axes of conductive films as represented at c' and d' and across the transverse axes at a and a' I connect the output circuit which includes the battery 22. The arrangement of the conductive films within the solenoid winding S' serves as a rectifier of amplified energy delivered by the conductive films within the solenoidal winding S'.

Figure 10 shows a method I may employ for setting up the magnetic field which threads through the conductive films. A pair of compressed silicon steel filing cores or other suitable magnetic material or alloys are arranged on opposite sides of the stack of alternately positioned conductive films and dielectric sheets. On these coils are provide the windings S2 and S3 supplied from the local source 21. The stack of bismuth or metallic alloy conductive films may be quite thick but the magnetic field is concentrically normal to the plane of the conductive films. The magnetic field in some cases is produced by a solenoidal coil of approximately 1000 turns on cores of compressed silicon steel filings. The resultant transverse pulsating direct current is several volts for only one milliampere flowing through the field coil and longitudinally through the conductive films in parallel. I have found that where four amperes alternating current at 60 cycle frequency is passed through a 12 turn coil and then through the conductive films connected in parallel with themselves longitudinally, the resulting pulsating direct current component across each conductive films is approximately 50 microvolts. When the conductive films above referred to are connected in series transversely 200 microvolts may be obtained. The values obtainable may readily be used in the operation of electron tubes. The arrangement of the apparatus is such that connections may be readily made with electron tube circuits as represented at Figure 9 without their interposition of transformer systems.

When an iron core is used with the device of my invention with the proper permeability curve an asymmetric characteristic curve may be obtained with the device similar to that obtained with a triode tube. This ability of the device of my invention facilitates the generation of self-oscillations in the device. The device when properly connected will, therefore, operate as an amplifier or as an oscillator in addition to its properties as a rectifier.

While I have described my invention in certain preferred embodiments, I desire that it be understood that various modifications may be made without departing from the spirit of the appended claims.

Other U.S. Patents by Palmer Craig:

U.S. Patent 1,778,796 (Oct. 21, 1930): System & Apparatus Employing the Hall Effect
U.S. Patent 1,825,855 (Oct. 6, 1931): System & Apparatus Employing the Hall Effect

These patents largely repeat the claims of USP #1,322,129.

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http://news.google.com/newspapers?nid=999&dat=19270402&id=rqM8AAAAIBAJ&sjid=YfYFAAAAIBAJ&pg=3035,3721219

Bismuth-coated Device Is Invented by Youthful Georgian Student

No Batteries, No Tubes In New Set... the invention of Dr. Palmer Craig, youthful head of the depart ment of physics at Mercer ...

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http://books.google.com/books?id=micDAAAAMBAJ&pg=PA59&lpg=PA59&dq=Palmer+Craig+bismuth&source=bl&ots=1WEoPhyloa&sig=TtiVLGT76VhErxAnEn-4EStRWJk&hl=en#v=onepage&q=Palmer%20Craig%20bismuth&f=false
Popular Science - May 1927

... with this amazing invention of Dr. Palmer H. Craig, of Cincinnati. Bismuth plates, it is said, generate the energy to operate the radio set, and serve as detector ...

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http://gradworks.umi.com/DP/15/DP15709.html

The Hall effect with low magnetic fields

by Craig, Palmer H., Ph.D., UNIVERSITY OF CINCINNATI, 1926, 8 pages; DP15709

Abstract: The Hall Effect in bismuth for a magnetic field strength of from 0.07 to 1.00 gauss was accurately determined by improved methods. Production of the bismuth films. Various methods for obtaining excessively thin, homogeneous bismuth films were tried and compared, such as casting, electroplating, evaporating, sputtering, and metallic spraying, of which the last three methods were particularly successful. Measurement of very low voltages. By refinements made in the potentiometer and measuring circuits readings to one-tenth microvolt were accurate and reproducible. Magnitude of the Hall Effect at low fields. A curve is plotted showing the rapid decrease in the value of -R between 0.07 and 0.30 gauss, and comparison is made with the higher values of field strength. It is noted that by putting the Hall potential of one film in series with one or more other films we obtain comparatively high values of the Hall e. m. f. which may be applied to great advantage as an alternating current rectifier in radio and similar applications.

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http://prola.aps.org/abstract/PR/v29/i2/p332_1
http://adsabs.harvard.edu/abs/1927PhRv...29..332H

Physical Review, vol. 29, Issue 2, pp. 332-336

The Hall Effect in Bismuth with Small Magnetic Fields

Heaps, C. W.

The Hall coefficient for a bismuth plate of dimensions 0.011×0.9×2.0 cm has been measured for magnetic fields ranging from 0.07 to 2.40 gauss. The average value of the Hall coefficient, R, in this range was 11.5, and variations of R due to change of field strength in this range were less than experimental errors. For larger fields the Hall coefficient of this specimen decreased from 13.5 for a field of 650 gauss to 5.9 for a field of 8600. It is concluded that for similar ranges of field the data reported by Palmer H. Craig are erroneous, probably because of insulation leakage or uncompensated thermomagnetic effects. A simple method of making very thin bismuth plates is described.

Patents re: Bismuth Film

JP2011221048

Also published as: US2011244224 -- KR20110111249 -- CN102213777
PROBLEM TO BE SOLVED: To provide anti-reflection coating for infrared ray having excellent adhesion to chalcogenide glass and excellent weather resistance. ;
SOLUTION: An anti-reflection coating 13 is provided on a surface of a substrate 12 made of so-called chalcogenide glass containing sulfur, selenium, and tellurium as main components. The anti-reflection coating 13 comprises a first thin film 16 and a second thin film in order from the substrate 12. The first thin film 16 comprises bismuth oxide (Bi<SB POS="POST">2</SB>O<SB POS="POST">3</SB>). The second thin film 17

comprises yttrium fluoride (YF<SB POS="POST">3</SB>). ;

TW201126779

Flexible thermoelectric energy converter and manufacturing method thereof

Abstract -- Flexible thermoelectric energy converter and manufacturing method thereof are provided, it is to use mold to produce PDMS structure and then solidify the PDMS structure on a gold-plated aluminum foil to form an electroforming mother die which has plural deposition holes; and then use electrochemical deposition to deposit the n-type bismuth telluride (Bi2Te3) and the p-type alloy of antimony telluride (Sb2Te3) alloy into each deposition holes of the electroforming mother die to form a specific p/n thermoelectric thin film; next solidify a UV adhesive structure on the gold-plated aluminum foil and thermoelectric thin film as a flexible component structure. At this moment, tearing the gold-plated aluminum foil for making the thermoelectric thin film structure to combine the UV gel structure, after that use a silver paint as an electrically conductive electrode, spreading on the two ends of the p/n thermoelectric film in sequence and make it as an electrical conduction connected in series; Finally, connect a wire to solidify an UV adhesive structure on the exposed location of the series-connection and the p/n thermoelectric film, so as to wholly package the component, thus comprising the flexible thermoelectric energy converter and manufacturing method thereof.

TWI341756

Anti-oxidative fine copper powder and conductive paste with anti-oxidative fine copper powder

The present invention relates to an anti-oxidative fine copper powder and a conductive paste with anti-oxidative fine copper powder. The anti-oxidative fine copper powder includes a fine copper powder part and an anti-oxidative film. The fine copper powder part has a near-globular external surface and an outside diameter smaller than 1 micron. The ingredient of anti-oxidative film includes ascorbic acid and is substantially adhered uniformly on the external surface. The conductive paste with anti-oxidative fine copper powder includes: an anti-oxidative fine copper powder, a glass powder, a resin solvent, a bismuth powder, a zinc powder, and a vanadium pentoxide. The invention has the advantages and efficacies of preventing oxidation of fine copper powder, low fusing temperature, not reducing electrical properties of product during soldering process, and low cost.

TW201002863

Metal material with a bismuth coating

Also published as: EP2280096 -- US2011073484 -- MX2010012956 -- KR20110000755 -- WO2009145088

Provided is a metal material with a bismuth film attached, which has excellent coating properties, corrosion resistance and paint film adhesion, and which can be produced with little impact on the environment. The metal material with a bismuth film attached has a layer containing bismuth on at least part of the surface of the metal material, the numerical proportion of bismuth atoms at the surface layer of said metal material with a bismuth film attached being 10% or above.

CN102222672

Bismuth ferrite base film layer stacked structure capacitor and preparation method thereof

The invention discloses a bismuth ferrite base film layer stacked structure capacitor and a preparation method thereof, wherein the capacitor comprises a bottom electrode, a substrate, a buffer layer, a ferroelectric film layer and a metal point electrode in sequence from the bottom to top; the buffer layer is a manganese-doped barium strontium titanate film, the chemical formula is Ba0.6Sr0.4Ti(1-x)MnxO3, x is the mole equivalent of element manganese, and x is equal to 0.005-0.05; and the ferroelectric film layer is a bismuth ferrite base film, the chemical formula is Bi(1-y)LnyFeO3, wherein Ln is one of lanthanide, y is the mole equivalent of lanthanide, and y is equal to 0.01-0.2. The preparation method is simple, and the obtained capacitor is a storage cell of a ferro-electric field effect transistor; and the capacitor overcomes the defects that the bismuth ferrite base film capacitor on ordinary silicon substrate has the defects of poor interface performance and high working voltage, and has good energy storage performance

GB274112

Application of hall effect and similar electrical phenomena to radio and allied subjects

The transverse potential difference produced by the longitudinal passage of current through a conducting - plate in a perpendicular magnetic field is used for the rectification of alternating electric currents. In the application to a rectifier, shown in Fig. 4, alternating current is passed longitudinally from c to d through conducting plates 1, 2, 3 arranged in parallel and separated by insulating-sheets and thence through a solenoid S producing the perpendicular magnetic field. The transverse potentials in the plates are connected in series by suitable connection of the edges e, j. Since the longitudinal current and the magnetic field are both alternating, the transverse potential difference will be direct. According to a modification, **conducting-material on an insulating base is etched so that two systems' of films are in parallel longitudinally and in series transversely. The plates are then placed side by side instead of in stacks.**

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http://link.aps.org/doi/10.1103/PhysRevB.38.3818

Phys. Rev. B 38, 3818–3824 (1988)

Growth and characterization of epitaxial bismuth films

D. L. Partin, J. Heremans, D. T. Morelli, C. M. Thrush, C. H. Olk, and T. A. Perry

Physics Department, General Motors Research Laboratories, Warren, Michigan 48090

The present work describes the growth of the first thin (0.1–2 μm) epitaxial films of pure bismuth using molecular-beam-epitaxy techniques. These structures were grown at elevated temperatures on single-crystal barium fluoride substrates of <111> orientation. Electron-microscope observations show the films to be featureless and defect free on the scale of 0.1 μm. The films grow with their trigonal axis parallel to the <111> axis of the substrate, and Laue-backscattering pictures show they are epitaxial. Mobilities at room temperature are on the order of 2 m2 V-1 s-1, and increase to over 10 at 20 K and 100 at liquid-helium temperatures. These values are far superior to those of other bismuth films grown to date, and approach mobilities observed in single-crystal bismuth. Further evidence of their single-crystal nature is given by the temperature-dependent resistivity below 6K, which is more akin to that of a bulk single crystal, rather than polycrystal, bismuth, and by the thickness dependence of the film mobilities, which are limited by scattering on film boundaries. The carrier density, as deduced from Hall measurements, is in the range (4–8)×1024 m-3 at room temperature and decreases as the temperature is lowered, becoming constant below about 50 K at approximately 5×1023 m-3. We also observe Shubnikov–de Haas oscillations in the resistivity and Hall coefficient at 4.2 and 0.4 K. The carrier density calculated from the period of these oscillations correlates well with that found from Hall measurements.

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www.phys.ufl.edu/REU/2008/reports/yang.pdf

A Study of Electrical Properties in Bismuth Thin Films

When bismuth is grown in thin-film geometry, it exhibits unusual behavior as ...
Studies of thin-film bismuth, in comparison, have often been hampered by the ...

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http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?arnumber=5951630
Coherent phonons in polycrystalline bismuth film monitored by ultrafast electron diffraction

Bugayev, A.; Esmail, A.; Abdel-Fattah, M.; Elsayed-Ali, H.E.;
Appl. Res. Center, Old Dominion Univ., Norfolk, VA, USA

The generation of coherent phonons in polycrystalline bismuth film is observed by ultrafast time-resolved electron diffraction. The dynamics of the diffracted intensities from the (110), (202), and (024) lattice planes show pronounced oscillations at 130-150 GHz. The anisotropy in the energy transfer rate of coherent optical phonons is discussed.

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apl.aip.org/resource/1/applab/v24/i5/p220_s1

Picosecond infrared holography on bismuth film

Thin films of bismuth provide a holographic recording medium that requires no development and is sensitive into the infrared. At a spatial frequency of 1730 lines/mm the diffraction efficiency is 5% for an exposure of 50 mJ/cm2 at 1.06 μm. Interference holograms using a diffusive beam splitter for a picosecond Nd:YAG laser show sufficiently high resolution for plasma holography applications.

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www.fom.nl/live/english/news/artikel.pag?objectnumber=166751

Crystal structure of bismuth varies - Foundation for Fundamental ...

Oct 14, 2011 ... FOM PhD researcher Tjeerd Bollmann and his colleagues at the University of
Twente discovered this when they grew ultra-thin bismuth films ...

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adsabs.harvard.edu/abs/1941PhRv...60..570W

Note on the Photoelectric Threshold of Bismuth Films of Measured Thickness.

Authors: Weber, Alfred H.; Eisele, Louis J. Affiliation: AA(Department of Physics, ...

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http://onlinelibrary.wiley.com/doi/10.1002/pssa.2210220144/abstract

Peculiarities of the thickness dependences of the bismuth film structure and resistivity

P. G. Borzyak, V. I. Vatamanyuk, Yu. A. Kulyupin

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http://www.fom.nl/live/english/news/artikel.pag?objectnumber=166751
October 14, 2011, 2011/47
Crystal structure of bismuth varies

Thin bismuth films modify their structure under the influence of conducting electrons

The poorly conducting semi-metal bismuth assumes completely different crystal structures in thin films than in bulk form. The structure of the layers, distance between layers and number of layers appear to be formed such that exactly one standing wave of conducting electrons can develop. FOM PhD researcher Tjeerd Bollmann and his colleagues at the University of Twente discovered this when they grew ultra-thin bismuth films on a nickel substrate. Thin bismuth films are therefore probably far better conductors than the bulk crystal. The researchers published their unexpected result online today in Physical Review Letters.

Now the researchers have observed this phenomenon in thin bismuth films as well. They were surprised to discover that bismuth grows with an uneven number of layers at once: the Fermi wavelength of bismuth in bulk is about one hundred times greater than that of lead and so layers of bismuth just a few atoms thick were not expected to influence the Fermi wavelength at all. However, they did. Using a low-energy electron microscope, the researchers could see that the layers in a thin bismuth film had a distinctly different crystal structure than the bulk crystal. This crystal structure is always in balance with the distance between layers in the film and the Fermi wavelength: the bismuth modifies its structure and with that the distance between layers such that the total film thickness (of three or five layers) equals a multiple of the Fermi wavelength associated with the structure concerned.

Bismuth is an ambiguous material at several levels. A piece of bismuth ’hovers’ between being a metal or a semiconductor and is therefore termed a ‘semi-metal’. It has now been demonstrated that in thin films, bismuth modifies its structure, density and distance between layers, to maximise the energetic advantage that can be obtained from standing Fermi waves with a wavelength far smaller than in the bulk material. The researchers expect that the structures found in the thin bismuth films are far better conductors than ordinary bismuth. Other physical and chemical properties of the newly discovered crystal structures probably differ from those in the bulk bismuth as well. The researchers aim to study these properties by means of controlled growth.

Contact
Bene Poelsema, +31 (0)53 489 30 60

Reference

'Quantum size effect driven structure modifications of Bi films on Ni(III)'
Tjeerd R.J. Bollmann, Raoul van Gastel, Harold J.W. Zandvliet and Bene Poelsema; Physical Review Letters, 14 October 2011 (online 13 October 2011)

Figure 1. Wavelength adjusts to film thickness
The distances between two layers in a bismuth film of three layers (green dotted lines) are not the same as those in a film of five layers (blue lines).The Fermi wavelength that is associated with the three-layer bismuth fits exactly 2.5 times in the total film thickness. For five layers the distance between layers is slightly smaller. Here the associated Fermi wavelength fits exactly four times in the total film thickness.

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http://www.springerlink.com/content/p141r6l338q08r54/
Russian Journal of Physical Chemistry A, Focus on Chemistry, Volume 86, Number 4, 621-627, DOI: 10.1134/S0036024412040231

Physical Chemistry of Nanoclusters and Nanomaterials
Kinetic regularities of thermal transformations in nanosized bismuth films

E. P. Surovoi, L. N. Bugerko, V. E. Surovaya and S. V. Bin

Abstract -- Transformations in a nanosized bismuth layer are studied by means of optical spectroscopy, microscopy, and gravimetry, depending on the thickness (d = 3–120 nm), thermal treatment temperature (T = 373–673 K) and time (t] = 0.05–2500 min). It is established that, depending on the initial thickness of the bismuth films and the thermal treatment temperature, the kinetic curves of the degree of transformation are satisfactorily described within linear, inverse logarithmic, cubic, and logarithmic laws. The contact potential difference for the Bi, Bi2O3 films and the photo-electromotive force for the Bi-Bi2O3 systems is measured. An energy-band diagram for the Bi-Bi2O3 systems is constructed. A model for the thermal transformation of Bi films that includes the stage of oxygen adsorption, the redistribution of charge carriers in the Bi-Bi2O3 contact field, and the formation of bismuth(III) oxide is proposed.

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http://www.sciencedirect.com/science/article/pii/S0921452604000833

Parallel magnetoresistance of a polycrystalline bismuthfilm in high magnetic fields

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Abstract -- Magnetoresistance (MR) ratios r=R(B)/R(0) have been measured in parallel fields on a polycrystalline heat-treated bismuthfilm at different temperatures. MR ratios vs. B's exhibit “maximums” followed by decreases, described by a B-1 law. Electron Fermi energies have been extracted. The MR data are explained using a Landau tube “sweeping” model and a MR expression of Pippard and of Fawcett. There is a second maximum in the MR ratios at View the MathML source followed by a second decrease. This second decrease could arise from the “sweeping” of the next lowest Landau tubes outside the Fermi surface of the single hole pocket.

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http://adsabs.harvard.edu/abs/1941PhRv...60..570W
Physical Review, vol. 60, Issue 8, pp. 570-573

Note on the Photoelectric Threshold of Bismuth Films of Measured Thickness
Weber, Alfred H.; Eisele, Louis J.

The photoelectric threshold wave-length change with thickness in aged bismuth films deposited on Pyrex at room temperature in vacuum is investigated further with some important modifications in apparatus and method including measurement of the average film thickness and extension of the temperature range in which the DuBridge analysis is applied. The data show that the bismuth films are characterized by: (1), an initial value of the threshold wave-length (2497A average) fairly independent of film thickness for the first 44 atom layers; (2), a definite shift toward higher threshold wave-lengths occurring between 44 and 111 atom layers thickness; followed by (3), a steady increase of threshold wave-length with film thickness above about 111 atom layers. These results are in general agreement with the previous preliminary work but show some differences which are discussed briefly.

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jpsj.ipap.jp/link?JPSJ/77/014701/

Electronic Structure of Ultrathin Bismuth Films with A7

Using scanning tunneling spectroscopy and first-principles calculations, we have studied the electronic structure of two different ultrathin bismuth films on a ...

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www.opticsinfobase.org/oe/abstract.cfm?uri=oe-18-5-4365

High wavevector optical phonons in microstructured Bismuth films

Mar 1, 2010 ... We report the generation of high wavevector, large amplitude coherent optical phonons in a microstructured Bismuth film. A femtosecond laser ...

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http://prb.aps.org/abstract/PRB/v5/i6/p2029_1
Phys. Rev. B 5, 2029–2039 (1972)

Galvanomagnetic Studies of Bismuth Films in the Quantum-Size-Effect Region

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Bismuth films (200-1400 Å) were grown epitaxially on freshly cleaved mica substrates. These films consisted of a mosaic of equally oriented crystallites averaging several microns in diameter. The plane of the films coincided with the trigonal plane of Bi. We have studied the thickness dependence of the resistivity, the Hall coefficient, and the transverse magneto-resistance, by gradually varying the thickness of a single film which was kept under high vacuum during the entire experiment. The resistivity at 360 and 77 °K is a smooth monotonic function of the thickness. At 12 °K, we observed small oscillations in the resistivity and in the magnetoresistance. These oscillations are regarded as probable manifestations of the quantum size effect (QSE). The thickness dependence of the Hall coefficient is in striking disagreement with the predictions of the infinite-potential-well model. Better agreement between the theory and experimental results is obtained when we assume a less rigid boundary condition. Also for several films we have investigated the temperature dependence of these three transport coefficients and found it to be quite different from that of bulk bismuth. We have attempted to explain these results in terms of the behavior of the carrier concentration and of the different scattering mechanisms that can come into play in these films.

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http://www.physicsforums.com/showthread.php?t=453008

Measuring the thickness of a thin film of bismuth for Hall Effect experiment.

Hello there,
I'm an undergrad in my 3rd year and i'm doing an investigation into the 'Preparation of Thin Films and their use in Hall Effect measurements.
We are making thin films of bismuth on glass (with pre drilled terminals) in a vacuum system.
The way they suggest measuring the thickness is by measuring the mass of the film, although they are quick to point out that the scales arent the most accurate and will only give a very rough approximation.
One way I know read would work would be to have a rectangular / square segment of bismuth and measure its resistance, although im not entirely sure how to go about this from a practical perspective as the shape of the bismuth film isnt rectangular, is it possible to do this for any shape provided you can easily calculate the area?

What other methods would there be to calculate the thickness. We were told we could request any equipment within reason, I doubt they would give us high tech expensive spectroscopy equipment for example, however if you know of any reasonably accurate and not overly technical, as im only an average 3rd year undergrad, then I can at least ask and find out if its possible.

adwodon
PhysOrg.com

Re: Measuring the thickness of a thin film of bismuth for Hall Effect experiment.

Numerically, you can compute resistance for any shape, but you basically need to do finite element analysis. If you're comfortable with programming, it's not that hard to do.

If you place an coil next to thin conductor film and apply AC, the inductance of the coil at different frequencies will depend on the thickness of the material, so long as the film is thinner than the skin layer at that frequency. This could give you precision of about 1% in measuring the thickness if you set it up right, and all you'd need is an oscilloscope and a function generator.

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http://www.jstage.jst.go.jp/article/ejssnt/7/0/7_688/_article
e-Journal of Surface Science and Nanotechnology, Vol. 7 (2009) pp.688-692

Sono-electroplating of Bismuth Film From Bi(III)-EDTA Bath

A. Chiba1) and T. Kojima1)
1) Department of Materials Chemistry, Yokohama National University, Japan
Abstract:
BiOCH3COO and EDTA-4Na were dissolved in 2 mol/dm3 CH3COOH-2 mol/dm3 CH3COONa buffer solution, and was adjusted to pH4.1 by adding 2 mol/dm3 CH3COOH or 2 mol/dm3 CH3COONa. 100 cm3 of this electrolyte was used. Electroplated film was obtained in the range of 10-100 mA/cm2. Sono-electroplating was carried out smoothly, because the mass transfer accelerated with ultrasonic agitation and Bi ion was supplied to electrode surface. The mass transfer and crystallization processes were most affected with micro-jet and shock wave pressure. Best conditions of sono-electroplating were 0.10 mol/dm3 BiY-, pH 4.0-5.5, 298 K and 10 mA/cm2. Exchange current density and reaction rate constant in the sonication increased compared with that in the stationary state. As for this, an electron reaction became fast by the micro-jet or a shock wave pressure. The plated film was smoothness and denseness in sonication compared with that in stationary state. It was concluded that main factor that the surface became smooth was shock wave pressure. [DOI: 10.1380/ejssnt.2009.688]

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http://pubs.acs.org/doi/abs/10.1021/jp802802j

J. Phys. Chem. C, 2008, 112 (31), pp 12018–12023

Magnetotransport Properties of Electrodeposited Bismuth Films

B. O'Brien§, M. Plaza‡, L. Y. Zhu†, L. Perez‡, C. L. Chien† and P. C. Searson*§
Departments of Physics and Astronomy and Materials Science and Engineering, Johns Hopkins University, Baltimore, Maryland 21218, Department Fisica de Materials, and Universidad Complutense de Madrid, Madrid, Spain
Publication Date (Web): July 10, 2008
Abstract -- Bismuth is a semimetal with unusual transport properties, such as long mean free path and large magnetoresistance (MR) effect. Here we report on the influence of deposition potential, Bi(III) concentration, and thickness on the microstructure and morphology of bismuth thin films. Polycrystalline bismuth films were deposited on gold from bismuth nitrate solution. The texture of the films is strongly dependent on deposition potential and Bi(III) concentration, but only weakly dependent on film thickness. The film morphology is strongly dependent on deposition potential and on film thickness. The magnetoresistance (MR) of the as-deposited films was highly dependent film morphology and grain size. Understanding the structure-property relationships is an important first step in optimizing the transport properties of as-deposited films and patterned features.

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http://journals.ohiolink.edu/ejc/article.cgi?issn=10400397&issue=v22i0013&article=1460_esdbfosvohmi
Electroanalysis, Volume 22, issue 13 (July 2010), p. 1460-1467.

Ex situ Deposited Bismuth Film on Screen-Printed Carbon Electrode: A Disposable Device for Stripping Voltammetry of Heavy Metal Ions

Serrano, Núria1; Díaz-Cruz, José?Manuel1; Ariño, Cristina1; Esteban, Miquel1

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http://cat.inist.fr/?aModele=afficheN&cpsidt=16705070
Analytica chimica acta 2005, vol. 537, no1-2, pp. 285-292

Ex situ preparation of bismuth film microelectrode for use in electrochemical stripping microanalysis
Author(s)
HUTTON Emily A. (1) ; HOCEVAR Samo B. (1) ; OGOREVC Bozidar (1) ;
Abstract -- A study on the preparation and characterisation of ex situ formed bismuth film microelectrodes (BiFMEs) is presented, focusing in particular on their stable and reliable stripping electroanalytical performance. The potentiostatic pre-plating of the bismuth film onto a single carbon fibre substrate microelectrode was investigated and optimised with the aim of achieving long-term electrochemical and mechanical film stability. Several important film preparation parameters, such as plating agent, potential and time, and composition of the plating solution were examined with respect to the current signals of 40 consecutive adsorptive cathodic stripping voltammetry (AdCSV) measurements of trace Co(II) as model analyte. A comparison, also presented, of the stripping performance between bismuth and mercury film microelectrodes revealed a distinct practical advantage of the BiFME. The resulting optimised BiFME exhibited, besides excellent long-term film functional stability, attractive stripping analytical performance. Employing AdCSV with square-wave voltammetric detection, highly linear behaviour was obtained in the examined concentration range, with limits of detection of 70 and 90 ng/l and excellent reproducibility with 2.4 and 2.9% relative standard deviation at the 1 μg/l level (n = 10), for Co(II) and Ni(II), respectively, achieved using only 2 min preconcentration time in the presence of dissolved oxygen. In addition, the performance of the proposed ex situ prepared BiFME in both anodic stripping voltammetry (ASV) of Cd(II) and Pb(II) and in AdCSV of Co(II) and Ni(II) from the same test solution is demonstrated. The ex situ prepared BiFME represents a promising non-toxic, environmentally friendly microsensor for detection at microlocations and in microvolumes, in particular where in situ bismuth film electrode preparation is inappropriate, inconvenient or impossible.

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http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADP011026

Studies of the Dielectric Constant of Thin Film Bismuth Nanowire Samples Using Optical Reflectometry

Black, M. R. ; Lin, Y. -M ; Cronin, S. B. ; Rabin, O. ; Padi, M.

Abstract : Arrays of 10 to 120 nm diameter single crystalline bismuth nanowires have been formed inside amorphous alumina templates. Since bismuth has a small effective mass compared to other materials, significant quantum mechanical confinement is expected to occur in wires with diameter less than 5O microns. The subbands formed by quantum confinement cause interesting modifications to the dielectric function of bismuth, This study measures the dielectric function of bismuth nanowires in an energy range where the effects of quantum confinement are predicted (0.05 to 0.5 eV). Using Fourier transform infrared reflectometry, the dielectric constant as a function of energy is obtained for the alumina/bismuth composite system. Effective medium theory is used to subtract the effect of the alumina template from the measurement of the composite material, thus yielding the dielectric function of bismuth nanowires. A strong absorption peak is observed at approx. 1000/cm in the frequency dependent

dielectric function in the photon energy range measured. The dependence of the frequency and intensity of this oscillator on incident light polarization and wire diameter are reviewed. In addition the dependence of the optical absorption on antimony and tellurium doping of the nanowires are reported.

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http://www.jim.or.jp/journal/e/pdf3/44/02/285.pdf

Bismuth-film electrodes: recent developments and potentialities for electroanalysis

Abstract -- This article critically reviews the field of the recently introduced bismuth-film electrodes (BFEs). Topics include the substrate materials, the methods of forming the bismuthfilm and cleaning the electrodes, detection techniques, interferences and potential target analytes. Finally, it discusses the future prospects and the scope for BFEs in electroanalysis.

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http://prola.aps.org/abstract/PR/v66/i9-10/p248_1
Phys. Rev. 66, 248–252 (1944)

The Photo-Conductance of Evaporated Bismuth Films

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The electrical conductance of Bi films evaporated on Pyrex in high vacuum was measured when the films were "dark" and when illuminated with 2537A radiation. A photo-conductance effect was observed for all films less than about 292 atom layers thick whether the Bi was deposited at room temperature or at liquid-air temperature. The photo-conductance effect disappears with increasing film thickness much more rapidly for films kept at liquid-air temperature than for those at room temperature. For films deposited discontinuously (that is, successive layers are allowed to age), the effect disappears at about 11 atom layers thickness for liquid air-temperature-deposited films and at about 172 atom layers thickness for room-temperature-deposited films. The experiments definitely point to the conclusion that true photo-conductance is not present in these films, that the films which exhibit photo-conductance are patch-like in structure; therefore, the observed photo-conductance is assigned to photo-electric emission between film patches.

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http://www.osti.gov/energycitations/product.biblio.jsp?osti_id=7097214
Sov. J. Low Temp. Phys. (Engl. Transl.); (United States); Journal Volume: 3:9

Critical magnetic fields of ultrathin bismuth films

Critical transverse magnetic fields were measured in bismuth films 70 to 18 A thick. It was found that for the temperature range (5--1.8/sup 0/K) and fields investigated the relation H/sub C/(T) is linear in bismuth layers freshly condensed on a liquid-helium-cooled substrate. The slope dH/sub c//dT increases the film thickness decreases, attaining a value of 95,000 Oe/deg for the thinnest films. This increase is correlated with the increase in film resistivity, i.e., with the reduction in the mean free path of the conduction-band electrons. The value of the factor A obtained from the value of the critical magnetic field for a film about 20 A thick (H/sub C/ =Ax10/sup 4/ T/sub C/) is 9.5. Thus, in ultrathin bismuth films the critical magnetic field is much higher than the paramagnetic limit. This behavior is explained by the large spin--orbit scattering in freshly-deposited ultrathin bismuth films. When the thickness of the bismuth film decreases from 40 to 10 A, the density of states falls off by approximately a factor of two.
Authors: Lazarev, B.G.; Semenenko, E.E.; Tutov, V.I.
Publication Date: 1977 Sep 01
Research Org: Physicotechnical Institute, Academy of Sciences of the Ukrainian SSR, Khar'kov

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www.phys.ufl.edu/~afh/reprints/BiAu_APL.pdf

Large magnetoresistance of bismuthÕgold films thermally deposited ...
Bismuth thin films deposited onto glass substrates by thermal sublimation are polycrystalline with ... recent efforts4–6 to grow thin films of bismuth having high ...

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http://hdl.handle.net/2292/2460

Anodic films on Bismuth
Williams, David Edward
Issue Date: 1974
Reference: Thesis (PhD--Chemistry)--University of Auckland, 1974.

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http://www.chemeurope.com/en/publications/83306/directly-heated-bismuth-film-electrodes-based-on-gold-microwires.html

Directly Heated Bismuth Film Electrodes Based on Gold Microwires

As a nontoxic substitute for mercury electrodes, bismuth electrodes attained a lot of attention during the last years. In this report we describe for the first time the preparation of two different directly heatable bismuth-modified microwire electrodes. We characterized the electrochemical behaviour using cyclic voltammetry in acetate buffer and alkaline tartrate solution. The bismuth electrodes show a significantly wider potential window compared with bare gold wires. In the presence of picric acid as one example for the detection of explosives, the bismuth electrodes deliver higher signals. By applying heat during the measurements, the signals can be enhanced further. We used the temperature pulse amperometry (TPA) technique to improve the electrochemical response at the different types of electrodes. In this preliminary study, we were able to detect 3 ppm traces of picric acid.
Authors: Jacobsen, Martin; Duwensee, Heiko; Wachholz, Falko; Adamovski, Miriam; Flechsig, Gerd-Uwe

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jpsj.ipap.jp/link?JPSJS/76SA/200/pdf

Spin-Orbit Effects in Thin Bismuth Films

The magnetic field dependences of the resistance of thin bismuth films with a ....

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www.freepatentsonline.com

Electroless bismuth plating bath - Murata Manufacturing Co., Ltd.
Apr 26, 1994 ... Thus, it has heretofore been regarded impossible to form a bismuth film by electroless plating (refer to "Nikkei Hi-Tech Information" Jun. 2, 1986 ...

POST A COMMENT